COGNITIVE STYLE, ACADEMIC SELF-CONCEPTS, AND CREATIVITY AS PREDICTORS OF ACHIEVEMENTS IN SCIENCE AND MATHEMATICS

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Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (NARST), March 26-29, 1994 at Anaheim, California,

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INTRODUCTION

Three broad categories of psychological-aptitude constructs, namely, intellectual abilities, cognitive/learning styles, and academic motivation/personality characteristics, are generally considered as critical predictors of educational performance. Variables representing these different inter-related spheres of aptitude constructs influence different aspects of educational performance, or the same aspects in different ways (Corno & Snow, 1986). In Malaysia, studies investigating the relationship of these constructs with dependent variables such as academic achievements have been sporadic because of the lack of validated instruments in these areas.

Through the Norm Study Project at the University of Science Malaysia, a number of instruments designed to measure many of these psychological-aptitude constructs have been validated, and their corresponding norms are being established for a section of the Malaysian population. With the instruments being administered to the same population sample, important outcomes relating these constructs to academic achievements are available. This paper reports the empirical relationships between cognitive style, self-concepts, creativity, and achievements in mathematics and science for a cohort of Malaysian secondary school students.

THEORETICAL PERSPECTIVES

Messick (1976) define cognitive style as "information processing regularities to develop in congenial ways around underlying personality trends". Moreover, the most studied style constructs carry ability-like definitions, and are assessed using cognitive performance tests. Thus, Corno & Snow (1986) suggest that the constructs represent an overlap between individual differences in intellectual abilities and personality characteristics. Linn & Kyllonen's (1981) study of Field Dependence-Independence (FDI) support this position. Relationships between cognitive style and academic achievement have been well documented.

Studies on FDI cognitive style show that field-independent (FI) persons tend to be analytical and interested in theoretical and scientific problems (Anastasi, 1982). For example, Lee, Kagan & Rabson (1963) found FI students to have an advantage over field dependent (FD)

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[1] *Other members of the Norm Study Project are Wai-Kong Ng (Chairman), Maznah Ismail, and A.L. Lourdusamy*

students in learning analytical concepts, while FD students had an advantage in learning inferential or relational concepts. Moreover, FI students seem to perform better in certain areas of the curriculum, such as mathematics, sciences, and engineering, and other analytic fields, while FD students seem to perform better in curriculum areas that have a social value focus (DeRussy & Fulch, 1971; Witkin & Goodenough, 1981; Lourdusamy *et al.*, 1989).

Relationships between academic motivation constructs such as self-concepts and academic achievement have been well documented. Self-concept broadly refers to a person's perception of himself or herself formed through experience with and interpretation of one's environment (Shavelson, Hubner & Stanton, 1976). Research shows that self-concept is not a single, global entity, but multi-faceted and complex (Shavelson & Marsh, 1986; Marsh & Shavelson, 1985; Byrne, 1984; Marsh, Parker & Smith, 1983; Shavelson, Hubner & Stanton, 1976).

Many models of self-concepts have been proposed. Shavelson *et al.* propose a multi-faceted, hierarchical model of self-concepts in which general self-concept appears at the apex, and is divided into academic and non-academic self-concepts at the next level. Academic self-concept is broken into self-concepts in particular subject areas (e.g., mathematics and language). Non-academic self-concept is broken into three areas: social self-concept (which is broken into relations with peers and with significant others), emotional self-concepts, and physical self-concept (which is broken into physical abilities and physical appearance). While no one model to date has been sufficiently supported empirically, studies by Marsh *et al.* using self-concept measuring instruments based on the Shavelson model are providing increasingly stronger evidence in support of the hierarchical model (Byrne, 1984).

Hanford & Hattie's (1982) meta-analysis of past research on self-concepts show that self-concepts correlate significantly with academic achievements. In particular, specific facets of academic (e.g., mathematics) self-concepts correlate most highly with the corresponding matching-subject (e.g., mathematics) achievements (Marsh, 1992).

Intellectual abilities clearly holds a central position in bringing about learner achievement. In particular, intelligence and measures of prior knowledge correlate highly with general scholastic abilities and achievement measures. On the other hand, evidence relating creativity with academic achievement is less well-established. In particular, studies have shown only a modest relationship between intelligence and creativity (Kubiszyn & Borich, 1993). Creativity measures a different aspect of intellectual abilities that emphasizes divergent thinking rather than convergent thinking (Guilford, 1967). Tests of creativity require students to construct novel but appropriate responses to given situation. Such multiple and imaginative responses cannot be scored by computer because their individual acceptability must be judged. Tests of creativity, to date, have not enjoyed widespread use in the schools, and in research.

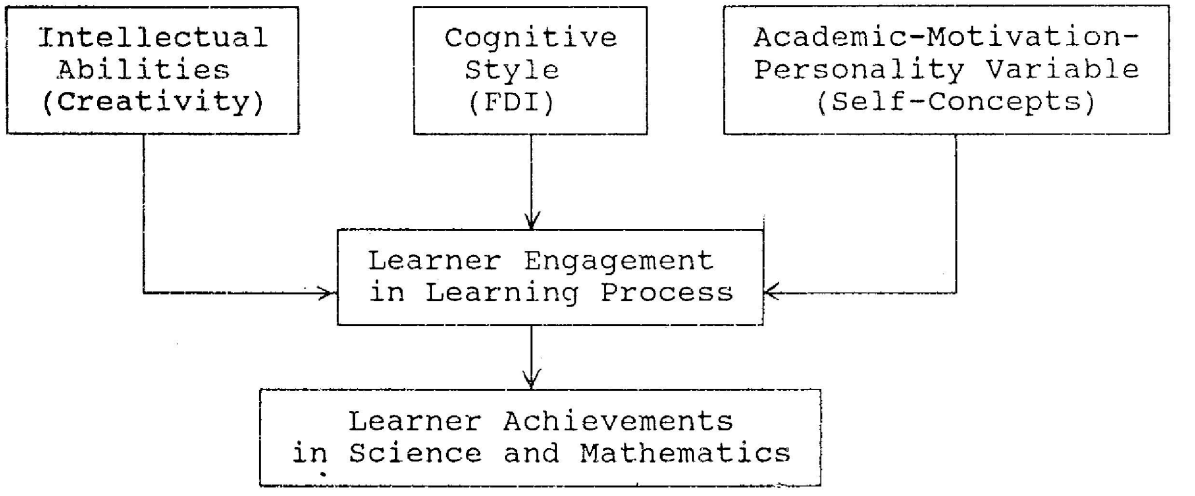
The most widely used set of tests of creativity that have the greatest amount of research accumulated are the tests designed by Torrance (1962). The Torrance tests yield measures of verbal and visual creativity in three traits, fluency, flexibility, and originality. Yamamoto's (1963) study suggested acceptable validity for the Torrance Tests (a correlation of 0.50 between

Torrance score and evaluation of imaginative stories for 40 fifth graders). However, the replication study by Wodtke (1964) suggests otherwise (r=0.24, holding IQ constant). The validity of the Torrance tests has not been clearly established, but evidence suggests that the Torrance tests probably come close to measuring essential aspects of creativity (Anastasi, 1982). In a study of ratings of the creativity of scientists in industry and their correlation with a number of tests, including some that measure divergent thinking, Jones (1964) shows that scores in verbal and reasoning correlated 0.3 with the criterion.

Hypotheses

The theoretical underpinnings relating the FDI construct of cognitive style, general and specific academic self-concepts, and creativity with academic achievements, especially in science and mathematics may be summarized diagrammatically in Fig. 1.

Fig. 1: The Theoretical Model of This Study



Specifically, FI is expected to correlate significantly with achievements in science and mathematics, as FI persons are more likely to be inclined toward analytical or technical subjects such as mathematics and science. Moreover, specific academic self-concepts in particular, are likely to correlate significantly with achievements in the corresponding specific subject. Similarly, thinking creativity is also likely to be significantly correlated with achievements in mathematics and science, as these subjects are by nature demanding very high conceptual and thinking skills. The null statements of these relationships form the hypotheses of this study.

METHODOLOGY

Sample

The sample consists of 366 secondary four students (aged about 16 years) from 4 schools. The 4 schools are selected from different parts of the country: one from East Malaysia and three

from different parts of West Malaysia. Two of these are rural schools, and the other two are semi-urban schools. They were among the schools that take part in the Norm Study Project. The ethnic composition of semi-urban Malaysia is reflected in the sample: 70% Malays (including other natives), 24% Chinese, and 6% Indians. All the students were from co-education classes. However, 130 students from one of the schools (representing about one-third of the sample) did not indicate their gender. Of the remaining 236 students, 30% are male students. The failure of a section of the students to indicate their gender causes a minor problem relating two specific self-concepts, i.e., same-sex relationship and opposite-sex relationship, to other variables. For these two constructs, the inter-correlations are based on a relatively smaller sample size compared with the other constructs.

Instruments

The FDI construct of cognitive style is measured using the Group Embedded Figure Test, GEFT (Witkin *et al.*, 1971). GEFT yields a bipolar measure of the extent to which a person's perception is influence by the surrounding visual fields: a higher score suggests FI (field-independence), while a lower score suggests FD (field-dependence). GEFT presents a series of structured but unfamiliar geometric pattern, and asks the subject to find it in a number of larger complex fields.

Self-concepts are measured using the Self-Description Questionnaire SDQ II (Marsh, 1990), which yields a general self-concept and a number of specific academic (e.g., general school, verbal, mathematics) self-concepts and non-academic (e.g., social, emotional and physical) self-concepts. The modified Malaysian instrument has a total of 111 items, where the verbal self-concept has been modified to become three separate self-concepts: verbal (referring to verbal/reading ability without specifying the language concerned) self-concept, the Malaysian Language self-concept, and the English Language self-concept. The modification is necessary because of the multi-ethnic nature of the Malaysian population, and because a Malaysian student learns not only the Malaysian Language and English Language but also the mother-tongue language. Students are required to rate each item in the SDQ on a six-point scale ranging from false, mostly false, more false than true to more true than false, mostly true, and true.

Two Torrance Tests (1962): Thinking Creativity with Words (TCW) and Thinking Creativity with Pictures (TCP), yield measures of verbal and visual creativities in three traits, fluency (total acceptable response), flexibility (how many of the categories listed in the manual does the subject use?), and originality (count of responses that are not in a standard list of frequent responses and that "requires intellectual energy ... away from the obvious and commonplace"). Summation of the three sub-measures gives the corresponding summated scores for verbal creativity and visual creativity

Procedure

Validated Malaysian versions of GEFT, SDQ, TCW, and TCP had been administered at different times over the school year to the same cohort of 366 secondary four students from

4 Malaysian schools selected from different parts of the country. All the students take a public examination, the Lower School Certificate (SRP) examination, and their mathematics and science achievement grades from the public examination are taken as dependent measures for this study. No item analyses or reliabilities data are available for these measures. Nevertheless, a number of studies (Yoong, 1977) correlating these achievement grades with standardized achievement show good concurrent and predictive validities (r's in the vicinity of 0.70 to 0.82).

The data were analyzed using the SPSSPC+ Version 3 on a micro-computer. Negative items in the questionnaire are inverted during statistical analyses. The science and mathematics grades are also inverted from the initial grading and scored from 1 to 9 so that higher scores imply higher achievement [9 and 8 being distinctions, 7-4 being credits, 3 and 2 being passes, and 1 being failure].

RESULTS

Reliabilities

Table 1 shows that most of the scales and sub-scales of the self-concept measures (SDQ), and the FDI construct of cognitive style (GEFT) have good reliabilities (Cronbach alpha ranging between 0.59 to 0.93). Both the Cronbach alphas and the test-retest reliability values of FDI cognitive style measures show consistently high reliabilities of this construct.

Table 1: Reliabilities of Self-Concepts and FDI Cognitive Style Scales and Sub-scales

SELF-CONCEPTS	RELIABILITIES N OF ITEM	N OF SUBJ	C'BACH ALPHA
GSELF	10	326	0.71
MATHS	8	326	0.88
VERBAL	4	326	0.59
ENGLISH	6	326	0.88
BM	9	329	0.90
GENSCH	10	326	0.80
PHYAPP	8	326	0.77
PHYABL	8	326	0.68
PREL	8	326	0.79
ETHICS	10	326	0.70
EMOSTB	10	326	0.76
OSEX(M)	8	61@	0.85
OSEX(F)	8	153@	0.78
SSEX(M)	10	61@	0.73
SSEX(F)	10	153@	0.78

SUMMATED SELF-CONCEPTS	RELIABILITIES N OF ITEM	N OF SUBJ	C'BACH ALPHA
ASELF	37	326	0.91
NASELF	62	153@	0.86
NSELF	44	326	0.87
TSELF	111	326	0.93
(FDI COGNITIVE STYLE)			
GEFT	18	326	0.90
GEFTA	9	326	0.83
GEFTR	9	326	0.81
GEFT r	-	343	0.80 #

@ number reduced due to failure of some subjects to indicate their gender

\# test-retest reliability (between GEFTA-GEFTB)

Malaysia is a multi-ethnic nation with three main ethnic groups: the Malays whose mother tongue is the Malay language, the Chinese whose mother tongue is the Chinese language, and the Indians whose mother tongues are the respective Indian languages (mainly Tamil). The home language of most of the Malays is their mother tongue, though a very small proportion uses a mixture of Malay and English. However, a nation wide survey shows that the home language of about half the Indians and about 15% of the Chinese is not the mother tongue but English or a mixture of English with the respective dialects (Atan Long *et al.*, 1984). Moreover, the subjects of this study are from secondary schools using Malaysian Language as the medium of instruction. Thus, the verbal self-concept used in a mono- or predominantly mono-ethnic cultural environment needs to be modified to take into consideration that self concept on verbal ability may be made with reference to any of these languages. In this study, verbal self-concept is separated from the Malaysian Language and the English language concepts. While the latter two refers specifically to either languages, the verbal self-concept refers to the self appraisal of verbal/reading ability of the language that the student is most proficient in, and this could either be Malaysian, English or the mother tongue languages.

Table 2: Inter-correlation between Sub-measures of SDQ Self-Concepts

	MATH	VERB	ENG	BM	SCH	APP	ABL	PREL	ETHICS	EMOSTB
VERB	.00									
ENG	.07	.25**								
BM	-.27**	.36**	.15*							
GENSCH	.31**	.46**	.36**	.30**						
PHYAPP	.06	.23**	.12	.29**	.36**					
PHYABL	.06	.02	.21**	.15*	.07	.18**				
PREL	.15*	.26**	.15*	.21**	.35**	.24**	.12			
ETHICS	.18**	.29**	.12	.17**	.34**	.16*	.01	.43**		
EMOSTB	.17*	.31**	.12	.09	.34**	.25	.23**	.32**	.26**	
GSELF	.25**	.40**	.32**	.30**	.60**	.42**	.18**	.49**	.39**	.45**

N of subj: 329 1-tailed Signif: * - .01 ** - .001

Table 2 shows the inter-correlations between various specific self-concepts. Verbal self-concept correlates significantly with both Malaysian language and English self-concepts. Mathematics self-concept correlates negatively with Malaysian language self-concept, suggesting that students with high mathematic self-concept tend to have low self-concept in the Malaysian language. General school self-concept correlates significantly with all the specific academic self-concepts and most of the specific non-academic self-concepts, the exception being physical ability. General self-concept correlates significantly with all the specific academic and non-academic self-concepts. Moreover, general school self-concept and general self-concept correlate as high as 0.60, suggesting that these two constructs have a lot in common.

No reliability data on the Torrance Tests of Creativity are available because scoring of the tests is by nature difficult and laborious. The inter-correlations (Table 3) between the various sub-measures of Torrance Tests show that verbal creativity and visual creativity are probably measuring different aspects of thinking creativity, since inter-correlations among the sub-measures of the respective verbal and visual creativities are generally higher when compared to the inter-correlations between the sub-measures of verbal creativity and visual creativity. The correlation between summated verbal creativity score and summated visual creativity score is low (0.15) but statistically significant.

Table 3: Inter-correlation between Sub-measures of Torrance Tests

	VFLUN	VFLEX	VORIG	PFLUN	PFLEX	PORIG	VERBCR
VFLEX	.60**						
VORIG	.75**	.28**					
PFLUN	.27**	.03	.28**				
PFLEX	.30**	.10	.31**	.85**			
PORIG	.06	.10	.08	.53**	.57**		
VERBCR	.94**	.68**	.87**	.26**	.30**	.09	
PICTCR	.21**	.09	.23**	.87**	.87**	.86**	.15**

N of subj: 360 1 -tailed Signif: * - .01 ** - .001

Descriptive Statistics

Table 4 shows that, on a rating scale points of 1 (low) to 6 (high), the self-concepts of the sample of students are generally on the fair to slightly high side, the only exception being English language self-concept. The Malaysian Language (BM), Parental Relationship (PREL), Same Sex Relationship (SSEX), and Ethics self-concepts of the sample are the highest. The specific academic self-concept scores show relatively higher variability.

In the cases of creativity measures, the mean verbal creativity score (VERBCR) is 22.08, with a range of 2 to 77, while the mean visual creativity score (PICTCR) is 54.45, with a range of 0 to 152. The relatively high standard deviations suggested a high variability in creativity scores among the students in the sample. The mean FDI score of the sample is 10.60, and the difference in the mean scores of the two sub-scales (GEFA & GEFB) of FDI measure is statistically not significant. On a scale of 0 to 18, it appears that more students in the sample are likely to be field independent (FI) than field-dependent (FD).

[1]As with academic achievements, the mean grades for science and mathematics are 5.35 and 4.60, respectively. on a grading scale of 1 (failure) to 9 (distinction), suggesting that most of the students obtain credits in science and mathematics.

Table 4: Descriptive Statistics of Self-Concepts, FDI Cogntive Style, Creativity, and Achievement Measures

Variable	Summated Mean	Scale Point	Std Dev	Min	Max	N
MATH	3.52	4	1.12	1.1	6.0	344
VERBAL	4.29	4	1.00	1.0	6.0	344
ENGLISH	3.23	2	1.30	1.0	6.0	344
BM	4.54	5	1.03	1.0	6.0	336
SCH	3.84	4	.85	1.6	5.7	342
APP	3.53	4	.92	1.0	5.9	338
ABL	3.60	4	.86	1.3	5.4	345
PREL	4.95	5	.84	1.3	6.0	345
OSEX	3.56	4	.98	1.1	5.8	215*
SSEX	4.69	5	.77	1.4	6.0	215*
ETHICS	4.56	5	.66	2.7	6.0	344
EMOSTB	3.76	4	.85	1.1	5.8	344
GSELF	4.36	5	.69	2.3	6.0	342
NASELF	4.01	4	.50	2.5	5.3	215*
ASELF	3.88	4	.63	2.0	5.4	335
NSELF	4.08	4	.51	2.5	5.4	337
TSELF	4.08	4	.51	2.7	5.2	214*
VERBCR	22.08		12.69	2.0	77	360
PICTCR	54.45		26.72	.00	152	365
GEFT	10.60		5.13	.00	18	343
GEFA	5.41		2.70	.00	9.0	363
GEFR	5.16		2.63	.00	9.0	343
SCACH	5.35		2.12	1.0	9.0	361
MATACH	4.60		2.60	1.0	9.0	361

* number reduced due to failure of some subjects to indicate their gender

@ Scale Point: [1] 1.00-1.83; [2] 1.84-2.67; [3] 2.68-3.50; [4] 3.51-4.33; [5] 4.34-5.16; [5] 5.17-6.00

Correlation and Regression Analyses

Table 5 shows that all the hypotheses are generally supported. Mathematics and science achievements correlate significantly with most specific academic (mathematics, Malaysian language, English language, and general school) self-concepts, the exception being verbal self-concept. Correlations with the Malaysian self-concept are, however, negative. In other words, high achievers in science and mathematics seem to have low Malaysian language self-concept. Science and mathematics achievements do not correlate significantly with any of the specific non-academic self-concepts or the general self-concept. In the case of summated self-concept scores, only summated academic self-concept (ASELF) [and not summated non-academic self-

concept (either NASELF or NSELF) and summated total self-concept (TSELF)] correlates significantly with science and mathematics achievements.

Table 5: Correlations between Self-Concepts, FDI Cognitive Style, and Creativity Measures with Science and Mathematics Achievements

Specific Self Conc	ACHIEVEMENT SCIENCE	MATHS
MATH	.40**	.63**
VERBAL	.06	-.08
ENGLISH	.19**	.11*
BM	-.25**	-.43**
GENSCH	.23**	.11*
PHYAPP	-.05	-.09
PHYABL	.01	-.04
PREL	.00	.02
@OSEX	.10	.14
@SSEX	-.08	-.10
ETHICS	-.04	.00
EMOSTB	.08	.03
GSELF	.06	.06

Summated Self Conc	ACHIEVEMENT SCIENCE	MATHS
#NSELF	.00	-.03
ASELF	.22**	.13**
@NASELF	-.04	-.09
@TSELF	.09	.02
(Creativity)		
VERBCR	.22**	.15*
PICTCR	.29**	.37**
(FDI)		
GEFT	.45**	.39**

@ N OF SUBJ = 211 (ALL OTHER CASES: N OF SUBJ = 317)

\# Exclude Same-Sex (SSEX) and Opposite Sex (OSEX) Relationships

With regards to the other measures, science and mathematics achievements are found to correlate significantly with FDI cognitive style (GEFT), verbal creativity (VERBCR), and visual creativity (PICTCR). The correlations are relatively higher with visual creativity than with verbal creativity.

Multiple regression analyses (Table 6) show that all the independent variables account for 49% and 56% of the variance due to the regression in the cases of science and mathematics achievements, respectively. Step-wise regression analyses show that a combination of 7 predictors best account for most of the variance due to the regression in science achievement, while a combination of 5 predictors best account for most of the variance due to the regression in mathematics achievement. The common best predictors for both mathematics and science achievements are FDI cognitive style (GEFT), mathematics self-concept (MAT), Malaysia Language self-concept (BM), English language self-concept (ENGLISH), and verbal creativity (VERBCR). In other words, field independent (FI) students with high mathematics self-concept, low Malaysian language self-concept, and high score in visual creativity tend to be high achievers in science and mathematics. Note that the correlation between mathematics and science achievements is fairly high (0.73). The single best predictor for mathematics is mathematics self-concept (which alone accounts for 40% of the total variance), and for science is FDI cognitive style (which alone accounts for 20% of the total variance).

Table 6: STEP-WISE REGRESSION ANALYSES: USING SPECIFIC SELF-CONCEPTS, FDI COGNITIVE STYLE, AND CREATIVITY MEASURES

DEPENDENT VARIABLE: SCIENCE ACHIEVEMENT			DEPENDENT VARIABLE: MATHEMATICS ACHIEVEMENT		
VAR ENTERED	R	R SQ	VAR ENTERED	R	R SQ
1.. *GEFT	0.45	0.20	1.. *MATH	0.63	0.40
2.. *MATH	0.54	0.29	2.. *BM	0.69	0.47
3.. *BM	0.56	0.31	3.. *GEFT	0.73	0.53
4.. *GENSCH	0.59	0.35	4.. *ENGLISH	0.73	0.54
5.. *VERBCR	0.61	0.37	5.. *VERBCR	0.74	0.55
6.. *ETHICS	0.62	0.39			
7.. *ENGLISH	0.66	0.44			
(THE REST)			(THE REST)		
8.. GSELF			6.. GSELF		
9.. PREL			7.. ABL		
10.. ABL			8.. PREL		
11.. APP	0.68	0.49	9.. APP	0.75	0.56
12.. PICTCR			10.. VERBAL		
13.. VERBAL			11.. PICTCR		
14.. EMOSTB			12.. EMOSTB		
			13.. ETHICS		
			14.. GENSCH		

* statistically significant predictors

DISCUSSIONS

The findings generally lend support to the growing evidence relating science and mathematics achievements to psychological constructs such as FDI cognitive style, self-concepts, and thinking creativity.

1. That field independent (FI) persons are more inclined to do well in analytical or technical subjects such as science and mathematics is well supported in this study. Indeed, FDI cognitive style is the single best predictor for science achievement, and one of the 5 significant predictors for mathematics achievement. Since FI students tend to have an advantage over FD students in learning analytic concepts, which are central to science and mathematics learning, it is recommended that the FDI construct be used as a predictive tool to diagnose student's inclination towards science and mathematics. This is very important considering that FDI cognitive style "develop in congenial ways around underlying personality trends" (Messick, 1982), and an individual's FDI cognitive style is often "set" even before he or she begins schooling. Since FI students have a strong orientation towards analytical fields (science, mathematics, engineering) and FD students are more oriented toward curriculum areas with a global, social value focus, the use of FDI construct in academic and career counselling is strongly recommended.

2. The inter-correlations among the various specific self-concepts and the correlations of these specific self-concepts with academic achievement demonstrate that academic self-concepts are distinct from non-academic self-concepts and general self-concept. Indeed, in this study, academic self-concepts [but not non-academic self-concepts and general self-concepts] correlated significantly with science and mathematics achievements. Additional data (not reported above) show that English language self-concept correlates significantly with English language achievement (0.42), but in the case of Malaysian language, the correlation is almost zero (0.04). Factor analyses data (Maznah & Yoong, 1994) provides support for Marsh-Shavelson's multifaceted hierarchical model of self-concepts (Shavelson & Marsh, 1986; Marsh & Shavelson, 1985), which postulate the general facet of self-concept as the apex of the hierarchy, divided into academic and non-academic components, and each component further dividing into more specific self-concepts.

3. That the single best predictor of mathematics achievement is mathematics self-concept provide evidence in support of Marsh's (1992) contention that academic self-concepts are remarkably content specific, i.e., academic subject specific self-concept tend to correlate highly with achievement in that subject. However, the usefulness of having too many content specific self-concepts often call into question. In particular, the relationship between content specific self-concept and achievement in the corresponding content areas is likely to be a two-way process, i.e., achievement in a given content area enhance the students' content specific self-concept, which in turn, brings about higher achievement in the given content area. Thus, only the more significant content areas are probably worthy of consideration. For science and mathematics education, mathematics self-concept probably serves the function well, since it is also a significant predictor of science achievement in this study.

4. With regards to verbal or language self-concepts, the case of the Malaysian language self-concept is unique in that it correlates negatively with mathematics self-concept and both science and mathematics achievements. In other words, Malaysian students who are high achievers in science and mathematics tend to have high mathematics self-concepts but low Malaysian language self-concept, even though the correlation of the Malaysian language achievement with both science and mathematics achievements are fairly high (0.54 and 045, respectively). That the correlation between Malaysian language self-concept and Malaysian language achievement is near zero (0.04) probably explains the situation, and this has a lot to do with the education system of Malaysia, where education is linked closely with social mobility.

In Malaysia, students are promoted automatically at each grade level for the first 9 years of education. At the end of the 9th year, students must pass the lower secondary public examination before proceeding to upper secondary level. After two years of upper secondary education, they must then pass another barrier: the Malaysian Certificate of Education examination. About one-fourth of these students proceeds to two year pre-university classes, where the Higher School Certificate examination is the final barrier to local university education. Because of the high competitiveness in entering tertiary education, over-obsession with examination and academic performance becomes the norm of Malaysian parents. At each level of public examinations, which is conducted in the Malaysian language, students must obtain a

pass in the Malaysian language in order to proceed to the next level. University entrance, however, demands that a student obtains a credit in the Malaysian language. In past few decades, there are significant instances of students who perform well and sometimes excel in most of the other academic subjects but fail to obtain a credit in the Malaysian language, the passport to further studies in local institutions. Thus, even though a student may have high mathematics self-concept, which in turn suggests that he or she is likely to be a high achievers, he or she may still feel threaten when comes to term with the Malaysian language examination. This explains the near-zero correlation (0.04) between the Malaysian language self-concept and Malaysian language achievement in this study. The low Malaysian language self-concept persists even though the student may also do well in the Malaysian language examination (Joseph, 1994).

5. To date, the search for a thoroughly validated creativity measure has limited success. Nevertheless, the amount of research accumulated around the Torrance Tests suggests that they probably come close to measuring essential aspects of creativity (Anastasi, 1982) that is different from conventional tests of mental ability. The high inter-correlations among the sub-scores within the verbal and visual tests of creativity suggest that the respective sub-scores are measuring essentially the same thing, as Cronbach (1970) had earlier noted. The relatively low correlation between the summated verbal and summated visual measures suggest that they measure different aspects of creative thinking. Of interest is the reverse trend of correlations between both creativity scores and science or mathematics achievements on the one hand, and between both creativity scores and Malaysian language achievement, on the other (Table 7).

Table 7: Correlations between Creativity and Achievements

ACHIEVEMENT	VERBCR	PICTCR
MALAYSIAN LANGUAGE	0.35	0.14
SCIENCE	0.22	0.29
MATHEMATICS	0.15	0.37

In this case, higher science or mathematics achievements seem to associate with visual creativity more than with verbal creativity. The reverse trend is true with Malaysian language achievement.

6. Educators have long acknowledged that school learning is strongly influenced by an individuals psychological attributes or aptitudes, where historically, tests of cognitive aptitudes are highly correlated with school achievement at all age range (Corno & Snow, 1986). Moreover, personality and motivational or affective attributes have been recognized to a play key role the students' tendency to persevere and excel in school learning (Wang, Haertel, Walberg, 1993). While cognitive aptitudes such as intelligence and prior knowledge are of prime importance to school learning in general, and science learning in particular, the influence of other cognitive attributes such as thinking creativity should not be overlooked. Although further research is needed in this direction, evidence from this study suggests that thinking creativity, especially visual creativity contributes to science and mathematics learning. The

implication for science and mathematics educators is that, where possible, science and mathematics should be linked to activities that enhance the teaching of creative thinking. As with personality and motivational attributes such as FDI cognitive style and self-concepts, evidence from this study and earlier studies suggests that science and mathematics educators must attend to these variables, especially in adaptive teaching with reference to individual differences. In order to develop effective lessons, science and mathematics teachers need to know the students orientation towards analytic learning, as diagnosed by FDI measure. Though researchers felt helpless in modifying or changing FDI orientation, the adaptation of science and mathematics instructions to teaching students who lack such orientations is particularly important. In the case of self-concepts, enhancing a student's academic self-concepts, especially mathematics self-concept, seems to be a strategy worth pursuing to bring about better achievements in science and mathematics learning.

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BIBLIOGRAPHY

1. Anastasi,A. (1982) *Psychological Testing*, 5th Ed.. New York: Macmillan
2. Atan Long *et al.*, (1984) *A Survey of the Reading Habits of Malaysian People*. Kuala Lumpur: Dewan Bahasa & Pustaka
3. Byrne,B.M. (1984) The general/academic self-concept nomological network: a review of construct validation research. *Review of Educational Research, 54*, 427-456
4. Corno,L. & Snow,R.E. (1986) Adapting Teaching to Individual Differences among Learners. In Merlin C. Wittrock (Ed.) (1986) *Handbook of Research on Teaching*, 3rd. Ed. New York: Macmillan, 605-629
5. Cronbach, L.J. (1970) *Essential of Psychological Testing*, 3rd Ed. New York: Harper
6. DeRussy,E.A. & Fulch,E. (1971) Field dependence-Field independence as related to college curricula. *Perceptual and Motor Skill, 33*, 1235-1237
7. Guilford,J.P. (1967) *The nature of human intelligence*. New York: McGraw-Hill
8. Hanford & Hattie's (1982) The relationship between self and achievement/performance measure. *Review of Educational Research, 52*, 123-142
9. Jones,F.E. (1964) Predictor variables for creativity in industrial science. *Journal of Applied Psychology, 48*, 134-136. Quoted in Cronbach (1970)
10. Joseph,C. (1994) Relationship between Self-concepts, Value system, Occupational aspiration and academic achievements of form four students from a MARA Junior Science College. M.Ed. dissertation (draft), University of Science Malaysia.

11. Kobiszyn,T. & Borich,G. (1993) (4th Ed.) *Educational Testing and Measurement: Classroom Application and Practice*. NY: Harper Collins College Publishers
12. Lee,L.C., Kagan,J & Rabson,A. (1963) Influence of a preference for analytic categorization upon concept acquisition. *Child Development, 34*, 433-442
13. Linn,M.C. & Kyllonen,P. (1981) The field-dependence-independence construct: some, one, or none. *Journal of Educational Psychology, 73*, 261-273
14. Lourdusamy,A. *et al.* (1989) Off-campus adult student characteristics (Malaysia) and their relationship to academic achievement. Penang: University of Science Malaysia. USM/IDRC Research.
15. Marsh,H.W. (1988) *Self-Description Questionnaire-I: Manual*, San Antonio, TX: The Psychological Corporation
16. Marsh,H.W. (1990) *Self-Description Questionnaire-II: Manual*, San Antonio, TX: The Psychological Corporation
17. Marsh,H.W. (1992) Content specificity of relations between academic achievement and academic self-concept. *Journal of Educational Psychology, 84*, 35-42
18. Marsh,H.W. & Shavelson,R. (1985) Self-concept: its multifaceted hierarchical structure. *Educational Psychologist, 20*, 107-125
19. Marsh,H.W. Parker,J.W. & Smith,I.D. (1983) Preadolescent self-concept: its relation to self-concept as inferred by teachers and to academic ability. *British Journal of Educational Psychology, 53*, 60-78
20. Maznah,I. & Yoong,S (1994) Self-concepts, scholastic achievements and Learning Process. Paper to be presented at the 23rd International Cogress of Applied Psychology, July 17-22, 1994 at Madrid, Spain.
21. Messick,S. (1976) (Ed.) *Individuality in learning: implications of cognitive styles and creativity for human development*. San Francisco, CA: Jossey-Boss
22. Shavelson,R & Marsh,H.W. (1986) On the structure of self-concept. In R.Schwarzer (Ed.) *Anxiety and cognition*. Hillsdale, NJ: Erlbaum, 305-330
23. Shavelson,R, Hubner,J.J. & Stanton,G.C. (1976) Validation of construct interpretations. *Review of Educational Research, 46*, 407-441
24. Torrance,E.P. (1962) *Guiding creative talent*. Englewood Cliff, NJ: Prentice-Hall
25. Witkin,H.A. & Goodenough,D.R. (1981) *Cognitive styles: essence and origins*. New York: International University Press
26. Witkin,H.A. et al. (1971) *A Manual for the Embedded Figures Tests*. Palo Alto, CA: Consulting Psychological Press
27. Wodtke, K.H. (1964) Some data on the reliability and validity of creative tests at elementary school level. *Educational and Psychological Measurement, 24*, 399-408
28. Yamamoto, K. (1963) Creative writing and school achievement. *School and Society, 91*, 307-308. Quotoed in Anastasi (1982), Cronbach (1970)
29. Yoong,S. (1977) Teachers' predictions of pupils' attainments in chemistry. Unpublished M.Ed. Dissertation. University of Malaya